

Assessment of anterior cruciate ligament (ACL) arthroscopic reconstruction using gracilis and semitendinosus tendon autograft

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Abstract

Aim: The purpose of this study is to examine the clinical features and MRI of ACL rupture and evaluate the results of ACL arthroscopic reconstruction using gracilis and semitendinosus tendon autograft.

Materials and Methods: This prospective study included 85 patients with ACL rupture getting ACL arthroscopic reconstruction using gracilis and semitendinosus tendon autograft at 7A Military Hospital (Ho Chi Minh City, Viet Nam) from July 2015 to December 2018.

Results: The results showed that ACL ruptures were common in men within working age; the ACL were often complete broken and has combined lesions, most commonly meniscus tears. 12.2 months of surgery, 86.2% of patients achieved very good and good results, 11.3% of patients achieved average results, and 2.5% of patients achieved bad results.

Discussion: Research showed that ACL arthroscopic reconstruction using gracilis and semitendinosus tendon autograft tend to be highly effective in restoring joint motor function.

Keywords

Anterior; Cruciate Ligament; Arthroscopic; Reconstruction Surgery; Gracilis; Semitendinosus; Tendon Autograft

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Introduction

An anterior cruciate ligament (ACL) plays an essential role in ensuring the normal motor function of the knee joint. Knee joint injury with ACL rupture makes the knee joint unstable. If not treated promptly, it will cause secondary damages to other components such as the meniscus, synovial membrane, articular cartilage, cartilage meniscus, causing osteoarthritis, and accelerate the knee injury process. Therefore, it is necessary to prescribe ACL reconstructive surgery [1].

The studies aimed at ACL recovery have been conducted by many authors over the years [2, 3]. In 1963, Kenneth Jones introduced an open surgery method using one-third of the patellar tendon threaded in a drilled channel through the lateral femoral condyle to replace the ACL [4, 5]. Recently, ACL reconstruction arthroscopy surgery has become routine in many places, minimizing invasive surgery, helping the joint functions recover sooner and more perfectly.

There are many materials used to reconstruct the ACL. The patellar tendon is a good graft; however, taking this material can cause complications such as weakening of the knee, rupture of the kneecap, prolonged pain in front of the knee [6]. From the above limitations, many surgeons chose gracilis and semitendinosus tendons instead. These grafts are easy to get, have little effect on function and aesthetics [7-11]. Therefore, we conducted this study to investigate the clinical features, specifications of ACL rupture image on Magnetic resonance imaging (MRI), and arthroscopy. At the same time, we assessed the results of ACL reconstruction through arthroscopy using gracilis and semitendinosus tendons.

Material and Methods

Subject, time and place of research

A total of 85 patients with ACL rupture underwent ACL arthroscopic reconstruction using gracilis and semitendinosus tendon autograft at 7A Military Hospital (Hochiminh City, Vietnam) from July 2015 to December 2018.

Selected patients were aged 17-50 years, having ACL ruptures due to trauma and having first time ACL reconstructive surgery. Excluded patients with ACL ruptures combined with other ligaments ruptures that needed surgery or reconstructive at the same time, patients with ACL ruptures with complicated knee joint injuries, patients with severe knee osteoarthritis, and patients with ACL ruptures were aged under 17 or over 50 years old.

Research design

Prospective research

- Sample size: Calculated by the formula:

$$n = \frac{X^2_{(1-\alpha/2)} p(1-p)}{(\epsilon p)^2}$$

In which: $Z_{1-\alpha/2} = 1.96$ (95% confidence coefficient), $p = 0.3$ (according to previous studies); $\epsilon = 0.4$. Inferred sample size: $n \geq 41$.

- Clinical characteristics: age, gender, cause, time of surgery, clinical symptoms.
- Clinical signs: drawer, Lachman, Pivot shift.
- Image characteristics of the injuries on MRI and arthroscopy.

Methods of surgery

The patient laid on his back, a tourniquet was placed around the thigh, an arthroscopic leg holder was placed to hold the thigh, the surgical leg hanged freely. After endoscopy ports were established to detect and diagnose injuries, combined lesions were managed, ruptured ligaments were cleaned. Preparation of grafts: gracilis and semitendinosus tendons were taken on the same side, two ends of the tendons were braided, tendons were doubled, the diameter and length to select the size of the bit to drill the tibial-femoral tunnel were measured.

Tunnels drilling: Tibial tunnel was drilled following the tibial tunnel locator from below the joint line and medial to the tibial tubercle to the center of ACL insertion. The femoral tunnel was drilled following the femoral tunnel locator, between the lateral intercondylar ridge and the posterior articular margin.

Threading and securing the drafts: the draft was threaded through the tibial tunnel into the femoral tunnel, the knee was hyper flexed 200, both ends were stretched, tendon was fixed to the tunnel. It was checked whether the drawer sign and the Lachman signs were no longer present. Drainage, closed the incision, placed knee brace. Rehabilitation included four stages [12].

Evaluation of surgical results: Early results include complications and surgical complications; later results were assessed according to the Lysholm scale (Very good: From 95-100 points, Good: From 84-94 points, Medium: From 65-83 points, Bad: Less than 65 points) [13].

Data processing

The data was processed by medical statistical method using SPSS software 15.0. and hypothesis test was done by the Chi-squared method.

Research ethics

Patients and family members who came for medical examination and surgery were consulted and agreed to participate in the study. Patients who disagreed were not included in the sample and did not receive any unfair treatment. The ethics committee of The 7A Military Hospital has approved the research content.

Results

Age and gender

Table 1. Patients distribution by age and gender (n = 64)

Gender \ Age	Age				Total	
	17-20	21-30	31-40	41-50	Number of patients	%
Male	01	22	15	07	45	70.3
Female	02	06	05	06	19	29.7
Total	03	28	20	13	64	
	4.7	43.8	31.2	20.3		100

The youngest age was 18, the oldest 49, the average: 32.2 ± 8.8 . The most common age group: 21-40 years old, accounting for 74.1%, male/female ratio =2.3. Men had ACL ruptures more often than women.

Causes

Traffic accidents and sport injuries were the most common causes, accounted for the 41 cases (48.2%) and 24 cases (28.2%), respectively. Daily life accidents and occupational accidents made up of 11 (13.0%) and 9 (10.6%) cases, respectively.

Time of surgery

Four patients (4.7%) had the surgery within less than one month after injury; 39 patients (45.9%) had the surgery at 1-3 months after the injury; 11 patients(12.9%) had at 4-12 months, and 31 patients (36.5%) had over 12 months. The average surgery time after the injury was 11.1 ± 18.9 months, the earliest was 0.6 months, the longest was 15 years; the majority was in group 1-3 months(39 patients, accounting for 45.9%), and after 12 months (31 patients, accounting for 36.5%).

Clinical symptoms included knee pain (94.1%), loose joints (70.6%), difficult moving (35.3%), joints swelling (24.7%), hydrarthrosis (17.6%), muscle atrophy (21.2%) and joint locks (2.4%) Eighty-two of 85 cases (96.5%) showed positive Lachmann signs, 71 cases (83.5%) positive front drawer sign, and in 42 cases (49.4%) positive Pivot shift test.

Table 2. Characteristics of the injuries on MRI of patients with ACL ruptures combining with other injuries (n=65)

Injury	Number of patients	%
Anterior Cruciate Ligament	65	100
Lateral meniscus tearing	22	33.8
Medial meniscus tearing	15	23.1
Tearing both menisci	16	24.6
Hydrarthrosis	15	23.1
Cartilage injury	14	21.5
Medial collateral ligament rupture	10	15.4
Partial Posterior cruciate ligament rupture	08	12.3
Quadriceps tendon rupture	05	07.7
Lateral collateral ligament rupture	01	01.6
Baker's cyst	01	01.6
Meniscal cyst	01	01.6

Completely ACL rupture on MRI accounted for a high proportion (56 patients, 65.9%) comparing to incomplet ACL rupture (29 patients, 34.1%). Ruptures of ACL with combined injuries (65 patients, 76.5%) accounted for a higher percentage than simple ACL rupture (20 patients, 23.5%). Combined injuries that commonly encountered were meniscus tear (81.5%): Lateral meniscus (33.8%), medial meniscus (23.1%), and both meniscus (24.6%); see Table 2.

Characteristics of knee injuries in arthroscopy

There were 72/85 cases of ACL completely rupture (84.7%), the remaining 13 cases (15.3%) had incomplete ACL rupture with lost tension.

ACL rupture with combined injuries: 66 patients (77.6%), ACL rupture alone: 19 patients (22.4%). Common combined injuries detected in arthroscopy were meniscus tear (80.3%), including lateral meniscus tear (36.4%), medial meniscus tear (22.7%), or both meniscus (21.2%); see Table 3.

Table 3. Characteristics of knee joint injury in endoscopy of patients with ACL ruptures combining with other injuries (n=66)

Injury	Number of patients	%
Anterior Cruciate Ligament	66	100
Lateral meniscus tearing	24	36.4
Medial meniscus tearing	15	22.7
Tearing both menisci	14	21.2
Partial posterior cruciate ligament rupture	09	13.6
Cartilage injuries	08	12.1
Synovial fluid inflammation	03	04.5
Synovial lining injuries	01	01.5
Disc-shaped meniscus	01	01.5

Treatment

All 85 patients (100%) received spinal anesthesia. There were 67 damaged menisci in 53 patients (including 24 patients with lateral meniscus tears, 15 patients with medial meniscus tears, and 14 patients with both meniscus tears) were trimmed and reshaped, 15 patients had meniscus sutured, and in no case the meniscus was wholly removed.

There were 8 patients with cartilage injuries (femoral condyle and tibial plateau) treated by the cut off excessive broken pieces. Two patients with both femoral condyle and tibial plateau fractures were treated by removed cartilage fragments and microfracture drilled to stimulate cartilage formation.

All patients were collected gracilis and semitendinosus on the same side (100%).

The length of the draft after doubling was averaging 103.8 ± 7.1 mm, the shortest was 95 mm, and the longest was 120 mm. The 7.5 mm diameter of the drafts accounted for a high proportion (57.6%), ≤ 7 mm accounted for 31.8%, and ≥ 8 mm accounted for 10.6%.

For the diameter of femoral and tibial tunnels, an 8 mm diameter accounted for a high proportion of 80%, 7 mm diameter accounted for 18.8%, and 9 mm diameter accounted for 1.2%.

The fixation tool for the femoral tunnel was the anchor XO button (100%). The fixation tool for the tibial tunnel was a wedge screw (100%).

Early results

There were 83 patients (97.6%) with primary intention healing, the suture was removed after 7-10 days, and rehabilitated as instructed. Two patient (2.4%) with complications from incision superficial infection had to have suture removal, cleaning and treated with strong antibiotics till stable.

Two patient (2.4%) had incision expansion to avoid corrupting the draft due to sophisticated donor tendon connections.

Two patient (2.4%) had hematoma after surgery, stabilizing after drainage.

After three months of surgery, 85.0% of patients achieved very good and good points, only 12.5% of patients achieved a medium score, and 2.5% of patients achieved a bad score (Table 4).

Table 4. Results of rehabilitation of motor movement after 3 and 6 months of surgery (n = 80)

Treatment outcomes	After three months		After six months	
	No. of patients	Percentage	No. of patients	Percentage
Very good	36	45.0	37	46.2
Good	32	40.0	32	40.0
Normal	10	12.5	09	11.3
Poor	02	2.5	02	2.5
Total	80	100	80	100

Long-term outcome after surgery

We could only follow up 80 patients with the shortest follow-up time of 6 months, the longest of 18 months, average follow-up of 12.2 ± 2.5 months. The remaining 5 patients were followed up in the provincial hospitals (outside of Ho Chi Minh city). All patients had good surgical scar healing, no pain or paresthesia in the scar area.

Long-term results: After the surgery (12.2 months), 86.2% of patients achieved very good and good points, only 11.3% of patients achieved a medium score, and 2.5% of patients achieved a bad score (Table 4).

Before surgery: No patients achieved very good and good scores; only 37.5% of patients achieved a medium score; the remaining 62.5% of patients had poor motor function score.

There was a significant improvement in the recovery of joint motor function after the surgery compared with the preoperative joint motor function (p <0.01).

Discussion

In terms of surgery time:

In our data, surgery 1–3 months after injury accounted for a large proportion of 45.9%. This was an appropriate time. Surgery, less than one month after injuries, had not been chosen. At this time, the knee joint would still be swollen with hematoma making it challenging to diagnose. The accompanying lesions (posterior ligament rupture) also had not been healed, limiting knee joints movement, and making it difficult for postoperative training.

The group that had surgery 12 months after injury also accounted for a high proportion (36.5%). Late surgery, when secondary lesions such as meniscus and cartilage degeneration had appeared, provided less ideal results. Therefore, timely diagnosis and appointment of operation are necessary.

About the value of clinical signs:

There are three clinical methods to detect ACL rupture. The Lachman test is an easy-to-see, specific test that gives reliable results. The Lachman test has outweighed the previous drawer test in a folding position. The Lachman test is made in a slightly folded position so that the collateral ligaments are the least strain; the meniscus does not hinder the forward movement of the medial tibial plateau. At that time, the only component against the forward translational movement of the tibia on the femur was the ACL.

The previous drawer test is also a standard test for detecting ACL rupture, although with less sensitivity. According to Muller W., although every examiner has his or her routine, it is

necessary to examine the drawer first in many degrees of knee flexion, because of the visible drawer mark one angle more than another angle. However, when flexed knee 90°, only the anterior ligaments are strain, and posterior ligaments are loose; therefore, when only the anterior ligament ruptured, the drawer test is considered positive [14]. According to Tria AJ, the front drawer method is more sensitive to the anterior ligaments, and the Lachman test is more sensitive to the posterior ligaments. The front drawer test is more sensitive when there is combined damage in the posterior cruciate ligaments [15].

In our study, 100% of the patients had ACL rupture, the majority (82 of 85 patients, 96.5%) showed positive Lachmann signs while only 71 of 85 patients (83.5%) showed positive front drawer test. The results were aligned with literatures that Lachmann test is more sensitive than front drawer test.

The Pivot shift test (semi-rotation sign) is a complicated and specific solution for ACL rupture. This test involves the phenomenon of anterior dislocations of the tibial plateau compared to the femur. This test is a valuable test for the diagnosis of complete and late ACL rupture.

Complete ACL ruptures were in 84.7% of our patients but nearly a half of them received early treatments. That can explain the result of only 42 of 85 cases (49.4%) in our study that showed positive Pivot shift test results.

Characteristics of knee injury on MRI and in arthroscopy:

ACL rupture with combined lesions accounted for a higher proportion than ACL ruptures alone (77.6% compared to 22.4% from endoscopy in our study, n=66). Combined lesions detected during endoscopy or preoperative MRI scan, most commonly meniscus tear (81.5% from MRI, n=65 and 80.3% from endoscopy, n=66 in our study), including lateral meniscus tear, medial meniscus tear, or both meniscus tear. When comparing MRI with arthroscopic results, MRI is valuable in ACL fracture diagnosis with a sensitivity of 93.9%, specificity 83.3%, and accuracy of 91.1% [16]. MRI is quite sensitive to detect combined lesions, helping to detect multiple lesions, including cartilage, collateral ligaments, and surrounding tendons, in both primary and secondary injuries [16].

The incidence of combined meniscus injuries were 69%, according to Shelbourne KD [17]. The rate of combined lateral meniscus injuries was high (63.5%), medial meniscus injuries 36.7%, and both meniscus 0.9% [9]. According to Nguyen TB, the incidence of meniscus injury accounted for a high proportion and affected the surgical outcome, although it was not known whether the damage was primary or secondary [1]. In our study, the rates for lateral meniscus, medial meniscus, and both meniscus injuries were 36.4%, 22.7%, and 21.2%, respectively. The results were similar to other authors in that meniscus injuries accounted for a high proportion of combined ACL injuries but different in the percentages of each types, which might highly depend on the causes and the patient characteristics.

About surgical techniques:

When taking the graft, be careful to avoid damaging the nerves of the front branch patella. According to Lawhorn KW and Howell SM, the incision for tapering gracilis and semitendinosus tendon was a diagonal or small anterior incision on the tibial tuberosity to limit damage to the sural nerve [11]. We often slit

the skin diagonally to remove tendons and to minimize damage to the sural nerve and to make the room into the tibial tunnel. When taking the tendon, should carefully peeled off, cut off all the sticking muscles to avoid breaking the tendon when using the tool to take it. The tool should be parallel to the line of the tendon. The braiding at both ends should also be done carefully so that the graft end could not be slipped out when screwing into the tunnel; the screw thread should not cut the graft.

The tibial tunnel plays an important role. The outer entry point is located on the upper edge of the goosefoot muscles, inside of the tibial tuberosity about 1.5 cm. The practitioner should avoid damaging the shallow part of the inner tendon and posterior tendon of the patella. The insertion point is just anteriorly between the tibia, slightly deviated to the inner side of the tibia, horizontal to the posterior edge of the lateral meniscus. The direction of the tunnel created with the tibial plateau at an angle of 45° - 55° and tilt 20° compared to the vertical plane.

Careful preparation and shaping of the inter-condylar area should be made when the gap is narrow, giving a clear view of the highest position to guide the femoral tunnel drilling accurately and to help prevent the graft blockage when extending the knee. Always leave the 2 mm on the posterior side of condyles to avoid breaking. The position of the tibial tunnel has little effect of changing graft length when the knee joint moves than that of the femoral tunnel.

Prior clinical research suggested that the most common failure in ACL reconstruction was the malposition of the femoral tunnel. If the graft located in the femoral tunnel in a too forward position, it might be too stretch when knee flexed and too loose when knee extended. Conversely, when the position of the femoral tunnel is too backward or too high, the graft will be too stretch when extended and too loose when flexed. Both types of malpositions lead to the same consequence, causing the new ligament to become slacked or secondary rupture rapidly.

In our study, after an average of 12.2-month follow-up, 86.2% of patients had good and very good score according to the Lysholm scale, only 11.3% had average score and 2 patients accounted for 2.5% got poor score. Among those who had average and poor score, no one failed due to the malposition of the femoral tunnel and no secondary rupture was found during the observing time.

Conclusion

After studying 85 patients with ACL ruptures who had reconstruction using gracilis and semitendinosus tendons, we concluded as follow:

ACL ruptures were common in men in working age. Standard surgery periods were after injury 1-3 months for the early group and over 12 months after the injury for the late group. The prominent symptoms were loosened knee (positive Lachman sign and front drawer sign). ACL was usually completely ruptured, with combined lesions, commonly meniscus tears that could be detected on an MRI scan before surgery or encountered and treated during surgery.

Arthroscopic ACL reconstruction using gracilis and semitendinosus tendons had high efficiency. Before surgery, 38.2% of patients got a medium score; the remaining 61.8% of patients had a bad score. After 12.2 months of surgery, 86.2% of patients achieved very good and good results, 11.3%

of patients achieved average results, and 2.5% of patients achieved bad results. There was an improvement in the recovery of joint motor function after surgery compared to preoperative function.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflict of interest

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